Quarterly Progress Report No. 2

Covering the Period October 1 through December 31, 1969

ACTIVITIES OF THE NASA-SPONSORED SRI TECHNOLOGY APPLICATIONS TEAM IN TRANSFER OF AEROSPACE TECHNOLOGY TO THE PUBLIC SECTOR

Prepared for:

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CONTRACT NASw-1992

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I INTRODUCTION AND SUMMARY

Much of the wealth of scientific and technological information generated or accumulated by NASA in support of the nation's aerospace programs can be used by public agencies concerned with the more everyday affairs of the population. Such a transfer of expertise, however, is not spontaneous. The applicable technical information first must be matched with needs. Implementation of the data is the equally important second phase. To these ends NASA has established its Technology Utilization Division with Technology Utilization Officers (TUOs) in each of the NASA centers. The Technology Utilization Division has contracted with several research organizations to assist in this program.

Stanford Research Institute has been selected to study the areas of air pollution, criminalistics, and transportation. The Institute's objective in this project is to apply the resources of an interdisciplinary Technology Applications team (TAT) to plan, coordinate, control, and evaluate a program for optimizing the match between public sector problems and potential solutions in the overall aerospace data bank. Emphasis is on public agencies west of the Rockies.

Dr. Charles J. Cook, Executive Director, Physical Sciences Division, serves as Team Supervisor. Dr. Lloyd P. Smith, Senior Scientific Advisor, Office of Research Operations, assists Dr. Cook and the other team members in an advisory capacity. Mr. William C. Thuman, Physical Chemist, has been assigned as Director of the Technology Applications Team, and is project leader for the studies in air pollution. He is assisted in the air pollution studies by Dr. Robert C. Robbins, Senior Physical Chemist, and Mr. Paul V. Roberts, Chemical Engineer. Dr. Aryeh H. Samuel, Program Manager, Criminalistics, is in charge of the work on Criminalistics. Mr. Edward C. Wood, Director of Applied Programs, is project leader for the transportation studies, and is assisted by Mr. Leslie R. Parkinson, Engineering Management Specialist.

The method of approach is essentially one of interviewing appropriate representatives in the public sector to learn of their technological needs; translating these expressions of needs into explicit problem statements; computer-searching the NASA data banks for potentially applicable references; conferring with the TUOs to obtain their assistance in introducing the TAT members to cognizant personnel at the centers; and proposing means of solving or helping to solve public sector problems through use of the data uncovered (technology transfer).

Reports are submitted monthly and quarterly; this is the second quarterly report. Progress in problem identification and technology transfer was as follows:

	Air Pollution	Criminal-istics	Transpor-tation
Problems accepted	7	9	5
Problem statements prepared or revised	7	9	5
Problem statements submitted to user	7	9	5
Problem statements submitted to WESRAC	16	10	8
Computer searches received from WESRAC	16	11	4
Visits to user agencies	5	3	3
Total cumulative active problems	16	15	12

II PROBLEM STATEMENTS

Twenty-one problem statements were prepared or revised during the report period. They are given on the following pages. Revisions are based on suggestions from the users.

PROBLEM STATEMENT

A Rapid Inspection Technique for Testing Compliance of Motor Vehicles with Emission Standards

What is Needed

An accurate, rapid, simple, standard, and routine procedure is needed for testing compliance of motor vehicles with emission standards.

Background

More than 50 percent of air pollution in most urban areas arises from motor vehicle exhaust. Exhaust emission standards and control devices have been the subjects of considerable study over a period of years. Although considerable progress has been made concerning exhaust control devices, little progress has been made in developing a rapid inspection technique for testing compliance of controlled motor vehicles with applicable emission standards. The materials in the exhaust that are of concern in compliance testing are hydrocarbons, nitrogen oxides, carbon dioxide, and carbon monoxide.

Constraints and Specifications

The exhaust inspection technique must measure instantaneously, automatically, and continuously the concentration of hydrocarbons in parts per million (ppm), the nitrogen oxides in ppm, carbon monoxide and carbon dioxide in volume percent, and exhaust volume. Associated with the technique, would be development of a standard, rapid, engine test cycle that would be simple to operate and representative of actual driving conditions.

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PROBLEM STATEMENT

Monitoring of Fluorides in the Atmosphere

What is Needed

A method is needed for monitoring atmospheric fluorides on a continuous or quasi-continuous basis.

Background

Fluorides are extremely toxic to animals and plants and are normally present in the stack emissions of aluminum and steel mills in gaseous or particulate form. Although a wide variety of plants are susceptible to fluoride damage, perhaps the more serious effect is on animals that may consume fodder containing relatively high concentrations of fluorides. The concentration of fluorides is built up in the animal over a period of time, eventually leading to fluorosis.

Although colorimetric, spectrophotometric, and fluorescent quenching are the basis of methods commonly in use, all methods are subject to interferences and an analytical time of up to seven hours may be required.

Constraints and Specification

The method should be continuous or should give readings at about fifteen-minute intervals. Interfering substances must either be eliminated or their effect on the measurement of fluoride must be corrected completely and automatically. The method should preferably be physical. It should be capable of detecting fluoride in the 0.1 part per billion range.

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PROBLEM STATEMENT

Disposal of Waste Wood

What is Needed

There is a need in selected areas for a nonpolluting method for the disposal of waste wood.

Background

About one-half of a tree is waste. Although some is used for products such as particle board, a considerable portion of the waste is incinerated. Current incineration methods including open (slash) burning produce smoke and other pollutants that seriously affect visibility over wide areas. The particle fallout and reduction of visibility associated with this burning seem to be one of the most troublesome air pollution problems in the Northwest today. The public attitude is currently changing to favor utilization of the waste rather than the long-accepted procedure of burning.

Constraints and Specifications

Mills associated with the lumber industry are generally small, and the cost of an incineration control device or alternate disposal method must be relatively low: a $10,000 control device, for example, may represent a year's profit.

Possible Solution

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

A portable chipper, spreading the chips for ground cover, may be a substitute for stack burning. Industrial utilization of various types of wood waste is possible if the economic problems can be resolved.

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PROBLEM STATEMENT

Stabilizing Waste Piles Arising from Mining and Smelting Operations

What is Needed

A method is needed to prevent wind entrainment of finely divided solid wastes, coal, and ores from mining and smelting operations.

Background

Huge quantities of waste--called tailings--arise from mining and smelting operations. As these tailings result from smelter slags and from using a flotation process for separation of minerals, very fine particles are usually produced. These fine particles are easily blown by the wind, causing air pollution problems. (As an example of the extent of these tailings, including smelter slags, one "pile" in Utah comprises 5,500 acres, 80 feet high.) Where control of this blowing dust is attempted, it is usually in the form of repeated wetting. The treatment is not very effective, because evaporation of the water and the rapid rates at which the material accumulates.

Constraints and Specifications

A method that would stabilize the pile permanently would be preferred. The method must be adaptable to large areas and to the rapid rate at which the material accumulates.

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PROBLEM STATEMENT

Continuous Measurement of Atmospheric Ozone

What is Needed

An instrument is needed for measurement of atmospheric ozone on a continuous basis.

Background

Daily ozone concentration maxima provide a valuable indicator of the progress of photochemical smog reactions. The monitoring methods that have been developed, however, are affected by other strong oxidizing components associated with the smog, such as nitrogen dioxide and peroxyacetyl nitrate. The measured values then are somewhat larger than the true concentration values for ozone and are reported as "oxidant." While maximum daily oxidant values can be used as a reasonable index of smog, using oxidants rather than ozone is a recognized practical compromise because no continuous analyzer for ozone has been developed.

Constraints and Specifications

The method must accurately and economically measure ozone on a continuous basis at concentrations in the range of 0.01 to 2.0 ppm, using either a physical process that is specific for ozone or using any other approach, provided that all interfering substances are either eliminated or are measured in such a way that their effect on the measurement of ozone is corrected for completely and automatically.

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PROBLEM STATEMENT

Development of an Atmospheric Beryllium Monitor

What is Needed

A rapid response instrument is needed that will provide continuous beryllium concentration data with an alarm activated by toxic threshold concentrations.

Background

Beryllium is under consideration as a high energy solid fuel for certain rocket applications. The extreme toxicity of beryllium oxide fumes is well known, and hazardous level beryllium contamination is a potential threat in the vicinity of rocket test facilities where beryllium fuel is burned. These facilities under normal test conditions have the capability of removing essentially all of the beryllium fume from the exhaust gases before release to the atmosphere. The potential threat exists because of the possibility of nonnormal operation during testing as a result of malfunctioning of some system component.

If significant amounts of beryllium fume are released into the atmosphere during a test, it must be detected and measured immediately so that there is sufficient time to do whatever is necessary to safeguard any threatened people.

Constraints and Specifications

An array of these instruments should closely surround the source site. They should have a response time of less than one minute and be capable of continuously measuring beryllium at concentrations between 1.0 and 1000 μg/liter of air.

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PROBLEM STATEMENT

Sulfuric Acid Mist Collector

What is Needed

A means is needed for completely removing sulfuric acid mist from a gas stream.

Background

Sulfuric acid is formed as the oxidized end product in many industrial exhaust streams containing sulfur gases. Sulfuric acid is an undesirable and highly visible air pollutant. It scatters light so strongly that the apparent density of the plume is much greater than that of an equivalent water droplet plume. This built-in detector should be taken advantage of in developing a method to remove completely the sulfuric acid from stack gases.

Constraints and Specifications

The necessary equipment for complete sulfuric acid removal should not be too expensive. Any approach that can accomplish the purpose is feasible from a technical viewpoint.

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PROBLEM STATEMENT

Digitization of Fingerprints

What is Needed

An automatic method to record, classify, transmit, and retrieve fingerprints is needed.

Background

Fingerprints are a major law enforcement concern. A vast number (more than a billion single prints) are on file in numerous locations. They are necessarily classified by a topological system (number of ridges between features) since successive prints of the same finger may vary in area covered and size. Classification is currently done manually, while retrieval from the file is done semimanually. There are two types of retrieval problems: (1) that to match a set of prints, the entire ten-finger classification being available, and (2) that to match a single print, which is much more difficult.

Considerable work has gone into revision of the system, so far without success. The problem can be subdivided as follows:

1. An optical reader or equivalent that will look at a print and convert it into a digital formula.

2. A way to store the formulas.

3. A quick way to retrieve either sets or single prints that match an input description automatically, preferably by remote interrogation from a teletype terminal.

Solving this problem is of direct interest to the citizen, because it will reduce the frequency and duration of mistaken arrests, and to the taxpayer, because it will reduce law enforcement costs.

Constraints and Specifications

It would be preferable to use the present classification system, but it is recognized that this may not be possible. However, any new classification system must be topological in nature, i.e. it must

give the same result for the same finger even if a different aspect has been impressed. Also it must give the same classification for an adult print and a baby print from the same individual. The classification system must be able to be resolved into individual finger classifications so that comparisons with single prints can be made.

Possible Approaches

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

Optical character readers have been developed that will read handwriting--this implies some sensitivity to form rather than size. The output of these and other readers presumably is in digital form so that tape, disc, and card storage are possible. Time-sharing computers appear to provide a framework for remote retrieval on demand.

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PROBLEM STATEMENT

Classification of Evidence Items

What is Needed

Digital or analog systems to record, classify, store, and retrieve items of physical evidence, such as tool marks, firearms evidence, and footprints, are needed.

Background

Crime is a major problem of our society in terms of money cost, human cost, and social tensions. Law enforcement philosophies differ, but in all of them it is considered better when the actual perpetrators of crime are apprehended and convicted than when the wrong persons are. To further this goal, there is strong and increasing emphasis on objective evidence (as opposed, for example, to confessions). Much of this is physical evidence, such as tool marks, footprints, and firearms evidence (e.g., bullets). These have individual characteristics that allow the investigator to match them with characteristics of persons or objects suspected of being associated with the crime.

The current procedure is that the investigator visually compares the evidence found at the crime scene with reference items obtained from suspects or from a file and establishes a sufficient number of points of identity or difference. To do this, he must have the physical evidence or a photograph in his actual possession. This leads to great delay and inconvenience when he wants, for example, to interrogate a file in another city. Moreover, the process is extremely time-consuming if a large file is to be checked.

Basically it should be possible to automate this entire procedure. This would permit remote comparisons, reduce the expert man-hours required, and provide objective backup to the expert's opinion. It would enable scientific techniques to be applied to a much larger fraction of cases than is now possible.

Constraints and Specifications

We are dealing with a large class of phenomena, each of which may require a somewhat different approach. In all cases, however, the evidential item includes generic features (e.g., those common to all chisel marks) that have no evidential value and specific features

which alone are valuable. Ways to isolate the latter must be found. On the other hand, adventitious features (e.g., those that are different in two footprints of the same shoe or two bullets fired from the same gun) must not be allowed to obscure identity. This is a difficult task that so far has required the integrating and analytical ability of the human brain. Moreover, spatial transformations may have to be built in, e.g., two identical bullets must be correlated even if one has been rotated with respect to the other--there is no natural zero point.

Possible Solutions

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

It would seem that a complete solution would consist of several parts, such as:

1. A transducer, such as an optical reader or a mechanical tactile device, that will accept the evidence and convert it into analog or digital information.

2. A classification scheme hinging on the important specific features.

3. Analog methods or digital programs that will isolate the specific features (e.g., that will subtract an unfired bullet image from the fired bullet so as to leave only those features caused by firing) and allow their comparison with reference samples by means of the classification scheme.

4. Retrieval programs that can be operated by remote access.

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PROBLEM STATEMENT

Determining the Age of Writing in Documents

What is needed

A method of determining the age of written documents is needed.

Background

Several modern developments have made it harder to determine the age of documents, with special reference to the age of ink. Not only large sums of money, but the freedom and even the lives of individuals can depend on the ability of forensic scientists to perform this task.

When most documents were written in liquid ink, oxidative changes of the ink and reactions of its components with the cellulose and lignin of the paper permitted at least approximate dating. Ball point inks are now in nearly universal use. Typical ball point ink formulations include an oil-soluble or polyalcohol base, a dispersed polymer, and a dye or pigment. A number of formulations from the Chemical Formulary are included with this problem statement, as are formulations for typewriter ribbon ink and printing ink.

Information and ideas are now requested that can lead to analytical methods for determining the age of such ink deposits.

Constraints and Specifications

Any method must be essentially nondestructive, since the document will be required in evidence. Any destructive effect, such as chemical reaction of the ink, must be confined to small parts (1 square millimeter) of the writing.

Possible Solutions

(Note: This section is illustrative only and is not intended to preclude other solutions or avenues of approach.)

1. Detect, and estimate the rate of, chemical reaction of ink constituents with the atmosphere or the paper.

2. Detect, and estimate the rate of, diffusion processes across the ink-paper boundary, using microscopy, microchemistry, nondestructive testing methods (microprobe, activation analysis). Paper chromatography techniques and principles might be useful.

Ink Formulas

Ball-Point Pen Ink

Formula No. 1

Castor Oil	93
Aluminum Stearate	2
Oil-Soluble Dye (Calco Oil Blue N or "Phenoform" Bo. Conc.)	5

The aluminum stearate is dissolved in the castor oil by heating only to cause the stearate to pass into solution. The blue dye is then added, making certain that all of the dye is dissolved or the composition may be filtered through a fine screen.

Formula No. 2
U.S. Patent 2,623,827

Victoria Blue Oleate	56
Victoria Blue Phosphotungstic Toner	27
"Tween" 202	4
"Carbowax" 1500	4
Polyethylene Glycol 400	7

Formula No. 3
Nontransferable Ball-Point Pen Ink

Polyethylene Glycol 400	10
Glycerol	84
Methyl Violet	6

Formula No. 4
U.S. Patent 2,882,172

Carbon Black	12
Mineral Oil	50
Oleic Acid	6
Hydroabietyl Alcohol	32
Rosen	3.5

Formula No. 5

Victoria Blue Oleate	56
Victoria Blue Phosphotungstic Tone	27
"Crill" S.6	2
"Carbowax" 1500, mixed with Polyethyleneglycol 400	8 7

Formula No. 6
German Patent 1,064,663

Zapon Echt Orange	4.0
Hydroxyethylated Fatty Alcohol	58.0
Methylpyrrolidone	27.0
Sodium Chloride	1.8
Water	2.7

The paste from these ingredients is formed into an emulsion with water and good mixing. The viscosity depends on the amount of water added.

Formula No. 7
Black

Oleic acid	44
Estergum	33
Nigrosine NB base	23

Mix dye and oleic; add resin; heat to 90°C for 1 hr; filter and roller mill

Formula No. 8

Spirit Fast Blue MBSN	1
"Carbitol"	1

Formula No. 9

Victorian Green WB	1
1-3 Butyleneglycol	1
Octylenglycol	1

Typewriter Ribbon Ink
U.S. Patent 2,160,511

Carbon Black	6
Tricresyl Phosphate	15
Nigrosine Base	9
Diglycol Laurate	15

Nontacky Printing Ink
U.S. Patent 2,525,433

Alkaline Lignin	100
Diethylene Glycol	100

Dissolve at 100°C
Cool to 30°C and grind in on a three-roller mill

Carbon Black	20

This ink is dried by application of water.

Rotary Press Ink

Zein G200	100
Gum Rosin	100
Oleic Acid	20
Aqueous Ammonia (28%)	25
Water	600
n-Butyl Alcohol	60
Pigment	150

The alkaline dispersion of zein and resin in water is modified with 40 to 100 parts of organic solvent to make it less viscous and to produce a continuous film with high gloss when printing with the finished ink. The pigmented ink dries quickly and adheres to non-moistureproof cellophane, paper and paperboard.

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PROBLEM STATEMENT

Characterization of Synthethic Fibers

What is needed

A method to determine the nature of synthetic fibers under microscopic examination is needed.

Background

Microscopic examination of evidence is one of the most important tools of the criminalist. His aim is to associate the evidence unmistakably with items belonging to an individual. Many evidence items contain textile fibers, and broken textile fibers are the major constituent of domestic dust. Observation of a characteristic mixture of fibers in dust can lead to the description of a garment that will help in apprehending a criminal.

Natural fibers (cotton, wool, silk) can be identified under the microscope or electron microscope by morphological characteristics. Synthetic fibers are extruded monofilaments that in general present few or no distinguishing features. Since there are now many different types of synthetic fibers in common use, methods for differentiating them are required.

Constraints and Specifications

Techniques should be nondestructive if possible so that samples can be retained as evidence. However, microchemical techniques involving small scale dissolution of fibers are acceptable. Methods should be applicable in a general-purpose laboratory.

Possible Solutions

(Note: This section is illustrative only, and is not intended to preclude other solutions or avenues of approach.)

1. Specific stains for individual polymers.

2. In-situ preparation of easily identifiable derivatives.

3. Determination of characteristic physical constants, e.g., refractive index.

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PROBLEM STATEMENT

Simple Analytical Methods for Drugs

What is needed

Analytical procedures that do not require expensive equipment are required for determination of drugs.

Background

A large part of the work load of criminalistics laboratories concerns drug analyses. These are of two types: determination of the identity of seized samples and determination of drug levels in blood, urine, or other physiological specimens. The latter is much harder since the drugs are present at very low levels. The inability to perform these determinations may lead to wrongful convictions based on inferior evidence (e.g., the arresting officer may testify that a suspect "appeared to be under the influence of drugs"). It has been shown that chemical separation procedures followed by gas chromatography, with collection of the effluents for infrared spectrophotometry or mass spectrometry, is a satisfactory method. However, most criminalistics laboratories do not have any of this equipment. Simpler analytical methods are therefore being sought.

Constraints and Specifications

Methods suggested should presuppose a general wet-chemistry capability, UV-visible spectrophotometer, microscope, liquid-liquid and liquid-solid chromatography, possibly gas chromatography.

They should be applicable to small samples (5-10 ml) of blood or urine, containing normal intoxicating levels of various drugs. If test is for one drug only, it should require no more than a 1-ml sample.

Particularly desired are tests for tetrahydrocannabinal and LSD. Amphetamines, barbiturates, morphine drugs are also important.

Possible Solutions

(Note: This section is illustrative only and is not intended to preclude other solutions or avenues of approach.)

1. Spot tests

2. Thin layer chromatography

3. Microbiological tests.

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PROBLEM STATEMENT

Effect of Drugs on Driving Ability

What is needed

Quantitative information is needed about the effect of drugs on ability to drive.

Background

Drunk driving has long been recognized as a crime that greatly harms our society; drunk drivers kill more people than murderers do. Studies have been made that accurately correlate the loss of driving skills with the concentration of alcohol in the blood.

Recently the number of arrests for driving under the influence of drugs has grown sharply. Not only illicit drugs can impair driving ability; many prescription drugs also do, and so do some remedies that are sold over the counter, such as cold remedies. However, law enforcement authorities have little or no quantitative information on the effects of drugs, especially as these effects relate to the manual skills, reaction times, and judgment factors that constitute the ability to drive without accident.

One use for this information would be to help obtain convictions of motorists who drive under the influence of drugs. Another, far more important, use for this information would be in an information campaign that would allow members of the public to judge when their drug intake has been such that they should not drive. Such information about alcohol is available and widely disseminated, and probably prevents most of us from driving dangerously. It is not available for drugs.

Constraints and Specifications

None.

Possible Solutions

(Note: This section is illustrative only, and is not intended to preclude other solutions or avenues of approach.)

1. Results of biomedical experiments on humans, involving drugs, in which both drug concentrations in the blood and behavorial characteristics were measured.

2. Similar experiments on animals from which extrapolations to humans can be made.

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PROBLEM STATEMENT

Immobilization of Bombs

What is needed

One or more general methods are needed to render bombs harmless.

Background

All large police forces have bomb squads that must cope with bombs that are left by criminals. Political criminals, members of organized crime, psychopaths, and others use bombs to kill, terrorize, or inflict damage. The bombs vary from very crude to quite sophisticated. Many have timers; others are set off by closing a circuit (e.g., with the ignition key of a car); some even have temblor elements that will set them off when they are moved. One element that is common to most of them is that initiation is electric. In most cases the power is provided by internal batteries. In principle, other ignition methods are possible (e.g., a saucer of sulfuric acid balanced above a sugar-potassium chlorate mixture); but they are rare.

An accepted method of disarming bombs used to be to drop them into lubricating oil, whose viscosity would arrest mechanical strikers. This is no longer considered safe, and a disarming method is sought that does not require moving the bomb. New technology does not seem to have been applied to this important problem as yet.

Constraints and Specifications

Equipment must be reasonably portable, so it can be taken to upper floors of buildings and to places far from roadways. Both initial and running costs must be moderate.

Possible Solutions

(Note: This section is illustrative only, and is not intended to preclude other solutions or avenues of approach.)

One possible approach that has occurred to us is dousing the bomb with liquid nitrogen or some other cryogenic liquid. This should freeze any batteries and prevent electrical ignition, and might also be effective for some nonelectrical initiation methods. There are, however, some problems associated with this solution:

- Are there sufficiently portable vessels that will carry a sufficient amount of the liquid?

- Are there any possible deleterious effects of rapid cooling (e.g., thermoelectric voltages)?

- How do you cope with a bomb lying flat on the ground? Presumably you build a coffer dam around it before pouring the liquid nitrogen. What are materials and techniques that will enable this to be done quickly and effectively?

Please do not confine your thinking to this potential solution. Other ideas would be most welcome.

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PROBLEM STATEMENT

Characterization of Glass

What is needed

Practical methods are needed for the characterization and individualization of glass.

Background

Glass is one of the most important materials of physical evidence. Fragments of broken glass furnish evidence in many hit-and-run cases, burglaries, and other crimes. It is a deeply satisfying moment for an investigator when he can take a piece of glass found at the scene of a fatal hit-run accident and fit it precisely into the gap left in the broken headlight of the suspect's car. Unfortunately, it isn't always that easy. The glass may have been shattered into small fragments so that it becomes impossible to reconstruct the original piece; or the suspect's car may not be available, so that the investigator is trying to determine the glass characteristics to compare with the known properties of glass in different makes of car. For this purpose, he is of course primarily interested in those properties that vary from make to make; even more so, from batch to batch in the same make. These may include, but are not confined to, refractive index, elementary composition, and hardness.

Constraints and Specifications

Characterization methods should be nondestructive, should be applicable to small, preferably microscopic samples, and should preferably not involve very expensive equipment. However, the last constraint is not absolute because instruments in nearby research institutions may be available--you, for example, might be able to accommodate investigators in the vicinity!

Possible Solutions

(Note: This section is illustrative only, and is not intended to preclude other solutions or avenues of approach.)

Microtitration methods for refractive index, in which a glass sliver is immersed in a low-index liquid and a high-index liquid is added till the glass disappears, may be useful--what are the limits of disappearance? (Δn)?

X-ray fluorescence and activation analysis have been suggested for elementary analyses. X-ray diffraction may also be useful.

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PROBLEM STATEMENT

Metal Detectors

What is needed

A metal detector suited to police use is needed.

Background

Bullets are one, but not the only, type of metal object that is often sought in police investigations. Others are guns, keys, burglar's tools. These objects tend to be small. Sometimes they are buried in the ground or embedded in a wall or a tree.

Metal detectors of the type used to detect land mines are not very good for investigative use. An official of a major city police department states that "They will register every bottle cap on the ground but will miss most buried guns." Apparently specially designed detection instruments are needed.

Constraints and Specifications

The required detector must be portable; it would be desirable for it to be battery-operated. It must register quite small pieces of metal at some distance (e.g., a bullet buried 2-3 inches deep or a gun buried 2-3 feet deep). It whould be operable by untrained personnel and should cost no more than $500.

Possible Solutions

(Note: This section is illustrative only and is not intended to preclude other solutions or avenues of approach.)

One possibility is that the types of detectors currently in use might serve if their data handling system were improved to give greater sensitivity and discrimination. Lower noise level and greater bandwidth might contribute to this aim.

For further information or discussion contact

Dr. A. H. Samuel, Stanford Research Institute
Menlo Park, California 94025
Area Code 415. 326-6200, Ext. 3594

PROBLEM STATEMENT

Origin-Destination Pattern

What is Needed

A very inexpensive, portable device that can "mark" a bus passenger as he enters the bus and identify him as he leaves would make possible the development of equipment to take data on the origin and destination pattern and fare mix of a transit system.

Background

To do a good job of routing and scheduling their buses, large city bus systems need to estimate the number of passengers who travel daily between each bus stop and each other bus stop. Given an adequate sample of origin-destination data from which to establish a pattern, the transit operator can schedule the most efficient use of his equipment, minimize the number of transfers needed by most passengers and generally provide a faster, cheaper service. To get the necessary data now, transit operators periodically survey each route. Typically an employee rides the bus, records for each passenger the time, the bus stop of origin, and the stop at exit. He may also record the fare paid and whether the passenger took or used a transfer. He may even interview passengers who have transferred or will do so to obtain ultimate origin or destination. This is expensive, and often not very reliable. Bus operators would like to be able to record the data without having an employee on board to do so and without having to depend on cooperation from passengers.

Most of the elements of a system that will do the job are straightforward. The operator can afford to equip one bus in a hundred, for example, with recording equipment, clock, stop counter, or odometer reader. But the problem of determining the origin stop of a passenger who is leaving the bus is not solved. Given a workable solution to that problem the transit operator could specify and purchase the system needed.

Constraints and Specifications

No cooperation should be required of the passenger, indeed it would be well if he were unaware of the process. No change in the practice of boarding the bus at one door and usually exiting through another door should be necessary. Since a sample is wanted, all the passengers on the run need not be accounted for--but the sampling should not introduce a bias. Thus a device that could identify one passenger at a time but was unable to cope with a line of people in quick succession would be unacceptable.

Possible Solutions

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

One possible solution is to weigh all passengers at entry and exit. A preliminary statistical investigation indicates that a scale accurate to ±0.5 lb would permit unambiguous identification of about 20 out of 30 passengers, and would improve with fewer passengers. Of course, the hand rails would have to be part of the scale, and the device must not be misled by transients as the passenger steps on and off it.

Other ideas are welcome.

References

A computerized literature search of NASA's aerospace information bank has been performed, and the below-listed references were identified that appear to be applicable to the problem. However, many relevant references may not have been identified by this means, and any additional suggestions will be appreciated.

1. Continuous Registration of Body Weight, A. B. Hertzmann, F. Flath, B. Coleman, and L. S. D'Agrosa, Wright-Patterson AFB, Ohio, AMRL-TR-65-23; AD-619441.

2. Measuring the Weight and Rate of Pouring of Liquid Steel into Casting Molds, G. G. Bakradze, Autom. Control and Methods of Elec. Meas., Vol. II, Dec. 1965, p. 194-204 (NASA).

3. Mass Measurement of Man in a Zero Gravity Environment, A. L. Hall, K. B. Allen, and H. S. Fang. Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Palo Alto, Calif., Taiwan, University, Taiwan; Aerospace Medicine, Vol. 39, June 1968, p. 646.

4. Über die Abstosskräfte des Fussballens bei Gang and Lauf (The Repelling Power of the Ball of the Foot in Walking and Running), H. Schales, H. Groh, W. Baumann, and F. Kubeth, Ergonomics 10(6): 683-697, Illus. 1967 (Engl. and Fr. sum.)

For further information or discussion contact

Mr. E. C. Wood, Stanford Research Institute
Menlo Park, California 94025
Area Code 415. 326-6200, Ext. 3652

PROBLEM STATEMENT

Vehicle Locator

What is Needed

Transit operators and police and highway patrols need an inexpensive device to track a vehicle and compute its location coordinates for automatic reporting to a central dispatcher.

Background

The dispatcher in police and highway patrol operations now knows the location of the vehicles under his control only through voice communication and zone or route assignment. A system that would transmit the vehicle's location when interrogated by the dispatcher would permit its location to be identified when the officer is occupied outside, and eventually, the development of a more efficient dispatching system. The transit industry is studying demand-actuated systems--the Dial-a-Bus idea--in which buses do not run on fixed routes but vary their routes to pick up and drop off passengers on call. One of the necessary elements of such a system is fast, frequent communication of vehicle location to the dispatcher.

Several systems are under development to do this. They depend either on the installation of a city-wide network of detectors in the street or on an adaptation of the hyperbolic navigation principle (LORAN, GEE, etc.). None make use of the dead reckoning (DR) capabilities of the vehicle's odometer and steering gear. Yet a DR device may be the simplest and cheapest alternative, particularly when well mapped city streets and modern data processing equipment make the correction problem straightforward. Many vehicles are already equipped with two-way radio, some with auxiliary devices that will transmit a stored number on command (e.g., line and run number). Modifications to transmit coordinates would not be difficult. The odometer is available to track distance traveled. The missing elements are a device to compute the vehicle's heading from the steering wheel and odometer and a device to convert heading and distance to coordinates. Both may have been developed--in fact the second device is very similar in principle to a late World War II instrument, the Air Position Indicator.

Possible Solutions

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

The preferred solutions are existing designs of (1) a mechanism that can be adapted to input steering wheel angle and speedometer shaft rotation and deliver heading output as a shaft rotation, and (2) a mechanism adaptable to input heading and speedometer cable shaft rotations and generate X-Y coordinates in either a mechanical or electronic register.

References

A computerized literature search of NASA's aerospace information bank has been performed, and the below-listed references were identified that appear to be applicable to the problem. However, many relevant references may not have been identified by this means, and any additional suggestions will be appreciated.

1. Assistance in Development and Evaluation of Bearing, Distance and Heading Indicator (BDHI) Instrumentation, J. L. Leavens, Naval Air Development Center; NADC-AM-6610; AD-631152; 4 April 1966, 19 p.

2. Position Monitoring Devices, L. G. Whitten, Union Carbide Nuclear Company, Contract W-7405-ENG-26; Y-1506; 20 April 1966, 32 p.

3. Conceptual Design for Mobile Geological Laboratory Position and Heading Fix System, D. K. Breseke and H. W. Wilson, Bendix Corp., Contract NAS8-20273, NASA-CR-74080; BSR-1257; March 1966, 150 p.

4. Graphical Position Representation (Bildliche Standortdarstellung); T. S. Briggs, Ferranti, Ltd.; Luftfahrttechnik Raumfahrttechnik, Vol. 10, Sept. 1964, p. 248-251 (in German).

For further information or discussion contact

Mr. E. C. Wood, Stanford Research Institute
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PROBLEM STATEMENT

Improved Braking Capability

What is Needed

With increasing speeds comes the requirement for improved braking capability. It is necessary that a system be devised that can fully utilize, but not exceed, the tractive force that can be sustained without slide.

Background

The problem is to devise a high speed transit vehicle braking system that will provide reliable and effective braking with minimum discomfort to the passengers. In most systems, braking ultimately depends on adhesion, which is the friction sustained between a wheel and the running surface. When sliding occurs, there is a decrease in the traction that can be sustained. Therefore, it is important that the braking system be controlled so as to utilize fully, but not exceed, the tractive force that can be sustained without slide. One approach used on aircraft and currently being adapted for automobile application is an antilock system whereby the braking power does not exceed the tractive or adhesive force.

Alternative materials are being considered. However, beryllium, a prime contender, may have restrictive aspects such as cost, toxicity, and corrosion.

The various forms of braking employed in transit systems may be classified as:

- On tread (shoe)
- Off tread (disc)
- Off tread (drum, automatic)
- Track, electrical or mechanical
- Auxiliary rail, electrical or mechanical
- Aerodynamic
- Dynamic (motor as generator, energy dissipated)
- Regenerative (motor as generator, energy recovered)

Rockets have been proposed but rejected on mass transportation vehicles because of their size and cost. Comparatively little direct comparison and evaluation of alternative braking strategies and equipment have been carried out.

Constraints and Specifications

The requirement is for a braking system that will be positive and reliable. The system is contrained by the effect on passenger comfort and by the wear, replacement, and maintenance costs.

Possible Solutions

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

The following list of categories is provided for an initial search and is not all-inclusive. The importance of this problem may cause new or novel ideas to be generated.

- Brakes (for arresting motion)--Decelerators, dragulators, speed brakes, aircraft brakes, wheel brakes, vehicle wheels, and retarders (devices).
- Transportation--Rail transportation.
- Retarding--Stopping.
- Friction--Dry friction, frictional drag, sliding friction, abrasion, energy dissipation, mechanical impedance, surface properties, traction, wheel brakes, and surface roughness effect.
- Electric Connectors--Disconnect devices.

For further information or discussion contact

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or

Mr. E. C. Wood, Stanford Research Institute
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PROBLEM STATEMENT

Reflective Signs

What is Needed

A material or a coating for reflective signs that will prevent their becoming ineffective when in an atmosphere of fog or moisture is needed. A method is needed that will prevent condensation on the reflective sign surface or a material is needed which will not be affected by surface moisture.

Background

Reflective sign materials are rendered ineffective when there is moisture on the surface. One need but drive down a fog enshrouded highway to appreciate the need for effective signs. It is unfortunate that in rain or fog when maximum warning time is most necessary, the present signs become inefficient to the point of becoming a hazard because sudden awareness makes drivers react precipitatiously under adverse road surface conditions.

Constraints and Specifications

The potential hazards to people would require investigation, but it is anticipated that these should not be insurmountable. Any required external power source may be a constraint in some sign locations. The particle emitter (if radioactive material is used) may be required to have a half life in excess of 20 years. Strontium titanate may be applicable.

Possible Solutions

(Note: This section is illustrative only, and is not intended to bias other solutions or avenues of approach.)

Two methods of approach are evident. One would be to prevent moisture from forming or condensing on the sign surface. The second would be a reflective coating that would be unimpaired by the moisture.

The formation of moisture on the surface of the sign may be precluded by an electrostatic charge which would repel the water droplets. A radioactive source material might be placed in appropriate areas. This

has been suggested as a means of preventing precipitation static on aircraft. The radiation products given off are primarily beta rays. Another possibility is the use of alpha particles, which could change the charge or otherwise repel the moisture.

Plastic surface discharge by use of a radioactive material embedded in a dielectric surface is another possibility. It is reported that 3M Nuclear Products Division is manufacturing microspheres of polonium 210, an alpha source, in a resin. It is not known whether such an approach would be feasible.

Another possibility is the use of an ion-blower that would create an ionized air flow across the face of the sign and thus dissipate the moisture.

The alternative to dissipating the moisture is a paint or surface material that will retain its reflective qualities despite surface water formation. It may be that the aberration caused by the droplets can be converted into an asset even though the configuration of the basic sign letters may require modification.

Possible Search Strategy

Finding a solution to the reflective sign problem is one that is of most importance to every driver, and it is anticipated that some ingenious proposals will result from this task statement. As an aid to what may become a synergistic solution, the following search categories are suggested, merely as a starting approach. It is not anticipated that all categories will be in the computer data bank.

- Aberration--Crystal optics, distortion, spacial filtering
- Absorption--Continuous radiation, ionizing radiation, photo luminescent, transmissivity
- Acrylic Resins--Plastic, synthetic
- Actinide Series--Radium isotopes
- Acuity--Visual perception
- Adaptive Filters--Optical
- Adhesion--Wettability
- Advection--Atmospheric circulation
- Atmospheric Moisture--Water vapor, refraction, light transmission
- Brightness--Optical properties, luminance vision, radiance

- Color--Optical properties, light, visibility
- Dispersion--Fog, nuclear emulsions, mist
- Display--Visual
- Electronic Precipitators
- Emission--Light
- Flaking--Spalling, splitting, wear, peeling
- Flatness--Roughness, surface geometry
- Flat Surfaces--Surface properties, surfaces
- Gas Analysis--Gas composition, oxygen analyzers, exhaust gases
- Guidance--Map matching, homing devices
- Guidance Sensors--Optical measuring instruments
- Imager--Optical images, image intensifiers
- Indicators--Position indicators
- Ionization--Atmospheric, surface
- Light--Reflection, transmittance, visibility
- Light Scattering--Atmospheric
- Low Visibility--Haze
- Luminous Intensity--Brightness
- Measurement--Depth, acoustic, density, dimensional, flow, optical, photographic, comparators, moisture, profilometers
- Nondestructive Tests--Flaw detection
- Pressure Heads--Hydrostatic
- Pressure Measurements--Pressure sensors, weight indicators, pressure recorders
- Prisms--Prismatic bars
- Profiles--Topography

- Profilometers--Surface roughness
- Radioisotopes
- Radioluminous sources
- Reflectance--Surface properties
- Spalling--Fracturing
- Surface Properties--Roughness, cracks, defects, coarseness
- Tunneling (excavation)--Construction, drilling, rocks

For further information or discussion contact

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Area Code 415. 326-6200, Ext. 4478

or

Mr. E. C. Wood, Stanford Research Institute
Menlo Park, California 94025
Area Code 415. 326-6200, Ext. 3652

PROBLEM STATEMENT

Impact Data Analysis

What is Needed

Improved methods are needed for measuring and processing acceleration data from impact tests between automobiles and highway structures.

Background

Highway laboratories test automobiles and wayside structures--signposts, guard rails, etc.--under impact to develop structures offering durability and maximum protection to the driver. Most of the sensors used in these tests are accelerometers. These devices are used in many other fields as well, and the techniques of applying them and of processing the data derived are in constant development.

There are two areas of interest--application and data reduction. The first involves instrument and system selection, including the accelerometer itself, signal conditioning equipment, multiplexing equipment, and recording equipment. All of this is available commercially--only advanced state-of-the-art information is needed. The second area of interest involves data processing--analog-to-digital conversion, digital or numerical filtering algorithms and codes, Fourier analysis and Fourier transform computation and inversion, techniques for determining and correcting null point error, integration velocity and displacement.

Constraints and Specifications

In general, vibration sensors and inertial navigation devices are not applicable to the field. Techniques used in nuclear and conventional weapons testing, rocket launch measurements, human impact tolerance tests, etc., are directly applicable.

For further information or discussion contact

Mr. E. C. Wood, Stanford Research Institute
Menlo Park, California 94025
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III USER AGENCIES VISITED

During this report period the team members visited the following user agencies:

Utah State Division of Health
Salt Lake City, Utah

Washington State Air Pollution Control Board
Seattle, Washington

Los Angeles County Air Pollution Control District
Los Angeles, California

Statewide Air Pollution Research Center
University of California at Riverside

Air Resources Board
State of California Department of Public Health
Sacramento, California

Seattle Police Department Criminalistics Laboratory
Seattle, Washington

Scientific Investigation Division
Los Angeles Police Department
Los Angeles, California

Laboratory of Criminalistics of Santa Clara County
San Jose, California

Southern California Rapid Transit District
Los Angeles, California

Highway Safety Programs Office
Federal Highway Administration, Region 7
San Francisco, California

Second Symposium on Rapid Excavation
Sacramento State College
Sacramento, California

Details of these visits are given in the appendix.

IV WESRAC SEARCHES

Sixteen searches on air pollution (AP), eleven on criminalistics (C), and four on transportation (T) were completed by WESRAC during the report period. The search strategies were prepared by WESRAC. An average of about three relevant documents were identified for each problem statement, with the range from zero to thirteen. These documents are being ordered through WESRAC, and relevant references are being added to the problem statements. The fact that more than a month is necessary for obtaining hard cover copies of the references may cause a significant delay in completing some problem statements. Microfiche copies, however, are available from WESRAC within about a week for about one-third of the references. We are preparing problem statements, with references, for distribution to NASA TUOs before obtaining copies of the documents.

The searches completed to date are for the problem statements listed below:

AP-1 Measuring Stack Plume Opacity in Low Density Plumes

AP-2 Monitoring Reactive Hydrocarbon Pollutants in the Atmosphere

AP-3 An Improved Method for Monitoring Nitrogen Oxides in the Atmosphere

AP-4 An Objective Method of Assessing Odors in the Atmosphere

AP-5 Measuring Continuously the Particulate Background and the Source of Atmospheric Particulates

AP-6 Analyzing Dispersed Aerosols and Tracing the Sources by Identifying Their Respective Particulate Fraction

AP-7 Monitoring Organic Vapors in the Atmosphere

AP-8 Studying Aerosols in the Laboratory and the Atmosphere

AP-9 The Role of Aerosols in Smog Formations

AP-10 A Rapid Inspection Technique for Testing Compliance of Motor Vehicles with Emission Standards

AP-11 Monitoring of Fluorides in the Atmosphere

AP-12 Disposal of Waste Wood

AP-13 Stabilizing Waste Piles Arising from Mining and Smelting Operations (no pertinent references were obtained on this subject)

AP-14 Continuous Measurement of Atmospheric Ozone

AP-15 Development of an Atmospheric Beryllium Monitor

AP-16 Sulfuric Acid Mist Collector

C-2 Determining Immunological Properties in Physiological Materials

C-5 Characterizing and Individualizing Hair

C-6 Using Electron Microscopy in Individualizing Biological Samples

C-7 Automatic Comparison of Objects and Photographs

C-10 Determination of the Age of Writing in Documents

C-11 Characterization of Synthetic Fibers

C-12 Simple Analytical Method for Drugs

C-13 Effect of Drugs on Driving Ability

C-14 Immobilization of Bombs

C-15 Characterization of Glass

C-16 Metal Detectors

T-3 Derailment Detector

Search No. 83-494 Cryogenic Refrigeration of Wet Soil*

T-7 Improved Braking Capability

T-27 Reflective Signs

The results of WESRAC searches of problems AP-1 through AP-9, AP-11, and AP-12 were evaluated to determine whether the computerized facility was being used to its full potential and to obtain background information

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* A search strategy was prepared in advance of problem statement formulation to determine whether the costs of cryogenic refrigeration of wet soil for tunneling and construction support are within reason.

on the methodology of selecting pertinent references. The results of this evaluation are discussed below.

Number of Relevant References Identified

The synopses of references received from WESRAC have been reviewed by members of the TAT, to identify those documents applicable to specific problem statements. The searches for problems AP-1 through AP-9 have been reviewed independently by two members of the TAT. The AP-11 and AP-12 search results have been reviewed by one member only. The results of this review are summarized below.

Problem No.	Number of References in WESRAC Synopsis	Number of References Considered Relevant by TAT
AP-1	36	8
AP-2	16	6
AP-3	5	1
AP-4	17	5
AP-5	16	10
AP-6	69	14
AP-7	20	3
AP-8	29	4
AP-9	34	0
AP-11	8	4
AP-12	5	0

On the average, the number of documents considered relevant by the TAT has represented 20 percent of the number of documents included in the WESRAC synopses. The number of documents has not been corrected for duplication, i.e., applicability to more than one problem.

The low proportion of references reported in the WESRAC search that are considered pertinent by the TAT is a matter of concern, particularly because the criterion of pertinence used by the TAT has not been overly stringent.

Variation Between Reviewers

To test for variation between reviewers, WESRAC search reports for problems AP-1 through AP-9 were reviewed independently by two members of the TAT, with each reviewer listing those references that he considered

pertinent to each particular problem. Results are shown below. The number of references are totals for problems AP-1 through AP-9.

A methodology for testing for variation between reviewers is being developed.

	Number of References
Total listed by WESRAC	255
Judged pertinent by Reviewer A only	11
Judged pertinent by Reviewer B only	23
Judged pertinent by both A and B	17

Less than 7 percent of the references were judged pertinent by both Reviewers A and B. Reviewer B judged 16 percent of the references to be pertinent, whereas Reviewer A judged only 11 percent as pertinent. This disagreement between reviewers indicates the existance of differences in criteria used for judging relevance, and points to a need for refining and, if possible, quantifying these criteria.

Difficulties with the WESRAC Search

The foremost problem has been failure of the WESRAC search procedure to find relevant references. The worst example of this deficiency occurred in the case of problem AP-3, "Nitrogen Oxide Analysis in Smog." The WESRAC search revealed only five references, and only one of those five was considered even marginally useful in the judgment of the TAT. However, the WESRAC search for problem AP-2, "Detection and Analysis of Smog Components," turned up four additional references potentially useful for problem AP-3. Other instances were also discovered in which references were listed for a problem to which they were not relevant, but not listed for another problem to which they were relevant.

An associated difficulty is the failure of the WESRAC search procedure to eliminate some references that have not the slightest application to the problem statement under consideration. Often there appears to be no relation even to the descriptors used in the search strategy. It would be useful if search strategies could be devised that were capable of better discrimination in eliminating extraneous references.

It appears that in some cases, WESRAC specialists pay insufficient attention to the problem statement. Problem AP-12, "Disposal of Waste Wood," serves as an example. Although the problem statement specifically requires a solution other than burning, the search strategy of the WESRAC specialists included terms such as "incineration" and "incinerator."

V DETAILED REVIEW OF RELEVANT REFERENCES

The role of the TAT in evaluating references is currently being defined. Under consideration is the question of whether it is desirable for the TAT to review in detail references that appear, on reading of their abstracts, to be relevant to particular problem statements.

There are two ways in which such a detailed review of references might be useful. First, information would be gained that would permit enhancing the clarity and usefulness of the problem statements. In particular, it might be possible to offer additional examples of possible solutions. Second, it might be possible to estimate the probability of a successful transfer being accomplished. Such an estimate could be based on the number of pertinent references, the number of independent approaches found in the literature search, and the probability of success of the several approaches.

VI FUTURE WORK

Emphasis in the third quarter will be on problem solving after dispersing problem statements throughout the NASA Centers. We will, however, continue developing transfer methodology. Emphasis in the fourth quarter will include an evaluation of the transfer methodology developed to date.

Appendix

REPORTS ON VISITS TO USER AGENCIES

STANFORD RESEARCH INSTITUTE

To: W. C. Thuman

Date: November 10, 1969

From: R. C. Robbins

Location:

Subject: NASA Technology Utilization
Trip Reports October 27 to 31, 1969

Answering:

October 27, 1969

Utah State Division of Health
Salt Lake City, Utah

Agency representatives: Dr. G. D. Thompson, Director
Utah State Division of Health
Dr. G. S. Winn, Chief, Air Quality Section
Dr. Lynn Thatcher

TAT representatives: R. C. Robbins, W. C. Thuman
NASA representative: R. G. Bivins, Jr.

This agency is under considerable public pressure to reduce local air pollution. Many residents formerly lived in Los Angeles and moved to Salt Lake City to avoid smog. They now see pollution building up again. Also, the local fallout measurements get into the press and are a subject of general concern.

The Utah State Division of Health has several unusual air pollution problems. They were very pleased that NASA Technology might help them with solutions to their problems. Subjects discussed that haven't been brought up by others are given below.

The use of beryllium in fuel mixtures of test rockets in Salt Lake Valley poses a potential acute health hazard from inhalation of toxic beryllium compound aerosols. Although during routine testing essentially all of the beryllium is trapped, explosion or other malfunction could produce momentarily high aerosol concentrations. USDH needs continuous beryllium analyses to monitor these test sites.

A practical, efficient method for removal of H_2SO_4 mist from effluent gases is needed. The copper smelters of Utah produce more SO_2 than copper. A large fraction of this SO_2 is converted to sulfuric acid by Contact Process equipment. There is always residual H_2SO_4 mist in the tail gases from the Contact Process. This produces a large and highly visible plume.

A method is needed to prevent wind entrainment of finely divided solid wastes, coal, and ores from mining and smelting operations, including uranium tailings. These mine tailings and smelter slags accumulate at rapid rates and are usually in the form of fine powders. Where control of this blowing dust is attempted, it is usually in the form of repeated or continuous wetting. The treatment is not very effective and better methods for stabilizing these ore, coal, and tailing piles are needed.

A method is needed for measuring PAN (peroxyacetyl nitrate). This is already becoming a public relations problem--another example of how public pressure can determine the direction of R&D.

The disposal of automobiles has become a nation-wide problem. Open burning is illegal in Salt Lake City, compaction is not feasible, and equipment to shred cars costs in the region of $3,000,000. Incineration is presently the only alternative, though not a satisfactory one.

Dr. Thompson brought up a subject in the highway safety category. They are interested in obtaining the "anatomy" of auto accidents. He would like us to get in touch with him. E. C. Wood will call Dr. Thompson to initiate discussion.

October 28, 1969

Washington State Air Pollution Control Board
Seattle, Washington

Agency representatives: Mr. Peter W. Hildebrandt, Assistant Director
Washington State Air Pollution Control Board
Dr. Henry Droege, Chief, Division of Engineering and Compliance

TAT representatives: R. C. Robbins, W. C. Thuman, A. H. Samuel
NASA representative: R. G. Bivins, Jr.

This agency serves the entire state. They have jurisdiction over autos and Kraft mills, and in the future they will extend this jurisdiction to include other state-wide air pollution problems such as those presented by aluminum and sulfide mills. In addition, they handle all problems for the less populous 50% of counties that do not have local air pollution boards. Although they are in routine contact with NAPCA (through the NAPCA representative in San Francisco), they have had difficulty in obtaining answers to specific problems. They were quite interested in obtaining help in problem solving through NASA-TUD. The state has laboratories for monitoring and related activities, while local agencies have jurisdiction over control of about 90% of the sources.

Again, they emphasized the pressure placed on them by the public to control major sources. Out of 1,300,000 tons of total pollutant, 900,000 tons come from transportation sources, and pressure to control automobiles is increasing.

There is a need for a non-polluting method for disposal of wood waste. Current incineration methods produce smoke and other pollutants which seriously affect the visibility over wide areas. The visibility problem seems to be the most troublesome air pollution problem in the Seattle area today, and wood waste burning is the largest contributor. The attidude is currently changing from burning to utilization of wood waste products.

There is a need for a satisfactory method of measuring oxidant in an atmosphere containing sulfur dioxide. A relatively high concentration of SO_2 produces negative interferences in the operational KI methods of oxidant measurement. In Washington state an SO_2 scrubber is added ahead of the oxidant analyzer, but the scrubber may affect the oxidant measurements. If it can be conclusively proved that the scrubber has no effect on oxidant measurement, this would be one problem solution.

The disposal of autos was discussed again. At present they are burned, creating an air pollution problem. Burning will be illegal in 1970.

Alumina dust and cryolite are becoming a pollution problem as aluminum production increases. Although this problem is an important industrial engineering problem, it is highly unlikely that a solution could be found in the NASA data resources.

There is a great need for inexpensive monitoring apparatus that can be standardized to relate, for instance, pollution levels in Washington and California.

October 29, 1969

Los Angeles County Air Pollution Control District
Los Angeles, California

Agency representative: Mr. Robert L. Chass, Chief Deputy Air Pollution Control Officer

TAT representatives: R. C. Robbins, W. C. Thuman
NASA representative: R. G. Bivins, Jr.

Mr. Chass was rather skeptical about obtaining direct help with his problems of air pollution control from NASA Technology. He said that the people in the LAAPCD already have access to all of the information sources that they require. Although he recognized the role NASA technological transfer might take in the development of new and improved air pollution instrumentation, he felt that NASA Technology should work directly with the instrument manufacturers. The LAAPCD has the responsibility of controlling stationary source emissions and in addition they assist the California Air Resources Board in the policing and control of auto exhaust emissions. Virtually all of the current problems in Los Angeles are related to auto emissions and have been recognized and defined for a number of years.

Mr. Chass will contact his technical people in the LAAPCD to determine whether or not they have current problems that the NASA information bank might help solve.

October 30, 1969

Statewide Air Pollution Research Center
University of California at Riverside

Agency representatives: Dr. O. C. Taylor, Acting Director
Dr. Edgar Stevens

TAT representatives: R. C. Robbins and W. C. Thuman

The Center was established in 1961 to bring a focus to a wide variety of air pollution studies previously conducted independently on several U.C. campuses. It has become the basic and long-range air pollution research arm for the State of California, and interfaces in an important manner with all major public sector air pollution agencies in California. The staff is highly sophisticated concerning the needs of California air pollution control agencies, and consequently there was considerable overlapping of problems with those we have discussed at meetings with other control agencies. There were, however, several discrete problem areas that were emphasized. They are described briefly below.

A method is needed for continuous, or quasi-continuous, analysis of fluoride gases in the atmosphere. Fluorides are extremely toxic to animals and plants and are normally present in the stack emissions of aluminum and steel mills. Although a method has been developed based on fluorescent quenching and is currently in use, a more sensitive method with no interference is desired. The minimum capability acceptable is detection of 0.1 part per billion and a measurement at least every 15 minutes.

A method is needed for the continuous analysis of nitric oxide in the atmosphere. All present methods are based on the oxidation of nitric oxide (NO) to nitrogen dioxide (NO_2), followed by measurement of the NO_2 formed. None of these methods is satisfactory. This is an especially difficult problem because the chemical and physical properties of NO suggest no obvious high sensitivity approach to detection.

Air Resources Board
State of California Department of Public Health
Sacramento, California

Agency representatives: Mr. G. J. Taylor, Deputy Executive Officer

TAT representatives: R. C. Robbins and W. C. Thuman

Mr. Taylor expressed a somewhat different, more pragmatic approach to air pollution problems than we have encountered elsewhere. He is generally more interested in <u>what</u> you can change in the atmosphere and <u>how</u> you can evaluate the change, rather than in what's happening in the atmosphere. He is interested in manipulable ideas--not, for instance, in meteorology per se which is non-manipulable. He is, though, interested in problems related to the role of meteorology in pollution.

Mr. Taylor talked about the general problem areas involved in dealing with air pollution. First and most important is the perennial instrumentation area. In common with every other air pollution control agency, the California ARB needs improved, less expensive, continuous analyzers for statistical evaluation of atmospheric composition or air quality.

Although there is a large amount of information concerning smog reactions in the atmosphere, much of this information is based on chamber studies. The use of large volumes of an air shed for atmospheric chemistry studies may provide information unobtainable by any other means.

Long-term air pollution effects are not well understood. For example, there is some indication that eye irritation is decreasing relative to the other smog parameters, i.e., visibility reduction, plant damage, and oxidant concentration. If this effect is real, is it due to a change in human response or to change in atmospheric chemistry?

We will maintain contact with Mr. Taylor and the ARB and analyze these general problem areas in terms of possible applicable air pollution problems.

STANFORD RESEARCH INSTITUTE

To: W. C. Thuman

Date: November 6, 1969

From: A. H. Samuel

Location:

Subject: NASA Technology Utilization Trips Reports, October 1969

Answering:

October 28, 1969

Seattle Police Department Criminalistics Laboratory
Seattle, Washington

Agency representatives: Mr. George G. Ishii, Criminalist
Mr. Jan Beck

TAT representatives: A. H. Samuel, R. C. Robbins, W. C. Thuman
NASA representative: R. G. Bivins, Jr.

The Seattle Criminalistics Laboratory is attached to the City Police Department and is located in rather inadequate quarters in the Public Safety Building. Its civilian head, Mr. George G. Ishii, is the only full professional (B.S. level). His assistants are essentially technicians. He handles about 3,000 cases per year, mostly routine. This laboratory is ripe for expansion.

Mr. Ishii brought to the interview Mr. Jan Beck, an examiner of questioned documents who practices as a private consultant in Seattle but who obviously works closely with Mr. Ishii.

Mr. Ishii's attitude towards technology transfer was extremely positive. On several occasions in the course of the interview he said that such an effort was long overdue and expressed his willingness to cooperate in finding and trying out potential items of technology transfer. On the other hand, an objective assessment must cast some doubt on his ability to collaborate in terms of facilities and staff time. It is illustrative of his objective limitations that part of the interview had to be held in a coffee shop for lack of a suitable office in that building.

After an introductory statement by Roy Bivins, the interview turned to the specifications of problems suitable for technology transfer. The first problem mentioned was that of blood typing in blood stains and dried blood, which has already engaged our attention. The next subject of discussion was the coding of bullets and toolmarks. In each case, a code--preferably digital--is desired which will enable the construction of a central register, the exchange of information, and the identification of a bullet or toolmark without the physical transfer of the evidence. The growing mobility of criminals makes nationwide registry even more essential. One difficulty that was mentioned was the change in gun barrels as they are used. Picture transmission was suggested as one possible technique.

Mr. Beck then discussed problems in the area of documents. One of these problems is the reading and recording of impressions on second sheets. The use of ballpoint pens has increased the average depth of such impressions. The method in greatest current use is photography under grazing illumination. Perfection of a replica system is desired. All methods must be nondestructive. It was suggested that image enhancement methods such as those used by NASA on the Mariner photos might be used.

It was also stated that no method exists at this time for determining the age of inks. This applies particularly to ballpoint pen inks. Dyes in these inks do not change color with time rapidly or reproducibly. However, there are certainly volatile constituents which should be measurable. An added constraint is that all techniques relating to documents must be nondestructive.

Another potential area of investigation is analysis of the handwriting itself. The science of handwriting analysis is based on the concept of identity elements in handwriting and is 350 years old. It has not been possible to formulate its principles and it is taught by apprenticeship only. Mr. Beck stated that handwriting was affected by disease (especially Parkinson's disease), senility, alcohol, and other drugs.(However, in our Los Angeles meeting an opposite view was expressed.) Comments were also made on word frequency analysis as a means of establishing authorship.

Returning to criminalistics proper, the problem of individualization was again brought up. In all investigations it is not only necessary to determine the nature of a material, but also to find enough points of singularity to establish a high probability that it has the same origin as a reference sample. Among the materials mentioned for which this cannot yet be done were:

- Hair. Very little is known about variation of different hairs on one individual.

- Fibers. In particular, synthetic fibers have little variation when viewed under the microscope. Dye characterization methods are required.

- Plasterboard. X-ray diffraction has been tried.

- Fireclay (from safes). Traces are often found on burglars' tools but cannot be correlated satisfactorily with the source material.

The use of tracers (on bullets, stills, dangerous drugs) was also discussed. One possibly realistic plan is to add tracer patterns to lead used for reloading of shells.

The need for fast analytical methods for drug analysis was discussed. The reference is to samples of drugs rather than to the more difficult estimation of drugs in biological samples. The Seattle Laboratory does not even have a gas chromatograph but apparently uses thin-layer chromatography (TLC) with good success. Analytical methods for drugs suitable for small labs lacking expensive equipment may turn out to be a good technology transfer item.

October 29, 1969

Scientific Investigation Division
Los Angeles Police Department
Los Angeles, California

Agency representatives: Capt. Don Martin, Head of SID
Lt. Donald Mann, in charge of criminalistics section

TAT representatives: A. H. Samuel, R. C. Robbins, W. C. Thuman
NASA representative: R. G. Bivins, Jr.

The Scientific Investigation Division of the Los Angeles Police Department consists of six sections:

1. Latent Print Identification. Only for identification of fingerprints found in the course of investigation. Does not maintain regular fingerprint files.
2. Photography. All on-scene photography except accidents.
3. Polygraph. Used as investigative tool even though evidence is usually inadmissible.
4. Electronics and Sound Recording.
5. Questioned Documents.
6. Criminalistics (in the narrow sense) with the following specializations:
    a. Narcotics and Drug Analysis
    b. Blood Alcohol
    c. Comparative (tool marks, etc.)
    d. Firearms and Explosives
    e. Survey Unit (makes ground plans and drawings)

The entire Division is one of the largest criminalistics (in the broader sense) operations in the country in staff, budget, and case load. We did not speak to any civilian staff members. The police force members we interviewed were obviously men of long experience and also had a great deal of theoretical background.

Unlike other facilities visited, the LAPD has already collaborated with aerospace agencies, including JPL and private aerospace companies, but has not so far seen anything they could adopt. One of the subjects under consideration is a completely automatic method for classification, registration, and retrieval of fingerprints. This must take account of the topological basis of fingerprint identification, i.e., fingerprints may vary in coverage (area of finger registering) or even in size (according to the pressure applied) but only the relative positions of features in terms of number of ridges (not inches) count for characterization.

J. H. Wedstein at NBS is currently trying to develop such a method but is some distance from success. There would seem to be a possibility of technology transfer here.

Another area of potential technology transfer is work which may have been done by NASA on the effects of drugs. At present the police have no authentic data on the correlation of drug levels in the blood and driving ability, and would therefore welcome any experimental data on impairment of functions such as reaction time and motor ability. Also, data are sought on synergistic effects of drug combinations or of drugs and alcohol.

We discussed blood typing rather fully. This laboratory has performed typing of dried blood beyond the A-B-O typing; Lt. Mann stated that they could do M/N and S/s typing. I believe this is unique. Lt. Mann stated, however, that there were still difficulties with the simpler typing. In particular, when no agglutination is obtained, there is sometimes doubt whether this is an indication of "O" grouping or merely means that the sample is too old to give any agglutination reaction.

Tailing devices for cars were then discussed and a need for two kinds of devices was expressed: (1) a cheap (up to $25) non-reusable device that can be attached inconspicuously to a car and allow it to be followed by another car. This would probably use the RF spectrum but might involve UV, IR, or ultrasonics; and (2) a mark that can be put inconspicuously on the roof of a car and allow it to be followed by a helicopter. A possibility would be a fluorescent colorless solution that could be painted or sprayed on the roof and interrogated by a UV beam from the helicopter. (Since these two problems are not strictly in the criminalistics area as I understand it, I intend to turn them over to the law enforcement group of the IITRI TAT).

The tagging of bullets, explosives, and other materials, e.g., by rare earths, was discussed briefly.

A need for better metal detectors was expressed. Present detectors will register every bottle cap on the surface of the ground but will not detect buried guns reliably.

We also discussed the immobilization of homemade bombs. Nearly all of these relay on an electrical battery for firing, so that disabling it will inactivate the device. We suggested pouring liquid nitrogen on the bomb, perhaps building a coffer dam around it first so it can be immersed without touching it.

A continuing problem that was mentioned here also is the automated recording, classification, and transmission of identity data for people and objects: fingerprints, tool marks, bullets. The use of replicas for transmission in the interim was suggested.

Another need that was brought out was for a biological test for semen, specifically a precipitant that will react only with human semen. The acid phosphatase and fluorescence tests are not specific enough, while sperm that can be seen under a microscope disappears in twelve hours.

The identification of automobile make and year by reflection spectrophotometry (our problem statement C-1) was discussed and the opinion expressed that not enough is known about the variation of the reflectance spectra as a function of car age.

A need was expressed for kits to identify: (1) synthetic fibers, and (2) glass samples--in particular, to determine the refractive index non-destructively. Immersion methods were suggested (titrate a liquid mixture until the fiber or glass disappears, then determine refractive index of liquid).

Finally, a discussion of handwriting with the head of the SID questioned-document group elicited the opinion that neither disease nor deformity but rather mental characteristics exert the strongest influence on handwriting characteristics. This conflicts with Mr. Beck's remarks (trip report of October 28, 1969).

The attitude of Captain Martin and Lt. Mann was rather cautious at the beginning of the interview. They have had comparable interviews before with JPL and aerospace industry representatives and have not reaped too much benefit. The examples of nuclear activation analysis and of the paraffin test were cited as involving overselling and lack of careful work. However, we succeeded to some extent in giving the impression that we know what we are talking about, and at the end of the interview Capt. Martin was kind enough to say that we had spoken more to the point than previous interviewers. It is therefore believed that, if care is taken to screen concepts before they are submitted to them, the SID representatives will have a very positive attitude to technology transfer and that an excellent working relationship can be achieved. Exaggerated claims must be scrupulously avoided. The LAPD does have excellent resources and capabilities for proving out items of new technology.

Follow-up Visit by A. H. Samuel

Laboratory of Criminalistics of Santa Clara County
San Jose, California

November 30, 1969

This was a follow-up to the visit reported in the First Quarterly Report. The purpose was to discuss problem statements produced by SRI. Mr. Bradford's comments were very helpful and led to a recasting or rephrasing of several problem statements, in particular C-3. Mr. Bradford also pointed out some new results obtained with the scanning electron microscope as a tool for identification of the smaller particles from marijuana plants. These comments will be incorporated in Problem Statement C-6.

STANFORD RESEARCH INSTITUTE

To: W. C. Thuman

Date: November 10, 1969

From: E. C. Wood

Location:

Subject: NASA Technology Utilization
Trip Reports, October 1969

Answering:

October 29, 1969

Southern California Rapid Transit District
Los Angeles, California

Agency representatives: Mr. D. R. McCullough, Senior Planner
Mr. C. R. Gallagher, Assistant General Manager

TAT representatives: E. C. Wood, L. R. Parkinson, W. C. Thuman
NASA representative: R. G. Bivins, Jr.

This organization was selected for a visit because of its recently received approval to establish two bus lanes to which automobile traffic will not have access on the San Bernardino freeway. The development is an effort to determine whether the rapidity of this mode of transportation during rush hour will draw enough automobile users from the freeway to form an effective substitute for a rail rapid transit system. A bond issue for the latter was rejected by the Los Angeles electorate. We had hoped to develop special problems which may arise from this transit mode. Both Mr. McCullough and Mr. Gallagher, however, were involved primarily in the planning of future operations and not in the operating problems of the system, and they were clearly preoccupied with future developments both of the bus-way system and of a new proposal for rail rapid transit. The meeting resulted in no discrete problems of the type we seek, but the discussion did confirm the desirability of examining specific areas of technology in the hope that applications of detailed NASA technology might reduce costs or establish feasibility in future developments. Areas suggested are tunneling, moving sidewalks, guidance, speed control, and door control of driverless buses on fast bus-ways. Tentative arrangements were made for follow-up visits with the operating division during the week of November 10.

October 6, 1969

Highway Safety Programs Office
Federal Highway Administration, Region 7
San Francisco, California

Agency representative: Mr. William H. Oliver, Regional Director

TAT representative: L. R. Parkinson

Region 7 includes Arizona, California, Hawaii, and Nevada.

Mr. Oliver was cordial and willing to be helpful but noted that his office primarily evaluates state highway programs to determine desirability of federal support. As a result, he could suggest little in the way of discrete problems. Areas for further investigation suggested are:

(a) Means of determining cause and existence of highway traffic stoppages.

(b) Improved methods for drivers to report accidents and breakdowns.

(c) Fog measuring equipment that will actuate warning lights.

The Federal Highway Administration is increasing its activity in providing federal support for state and local action. It would appear that the appropriate contact for obtaining technology utilization opportunities will be the responsible state agencies, who may seek federal funding for implementation.

Our efforts to establish contact with the Urban Mass Transportation Administration were not successful due to the work load in that agency.

October 16 and 17, 1969

2nd Symposium on Rapid Excavation
Sacramento State College

E. C. Wood attended this symposium for background and contact source information on the problem of tunneling. Comparing this symposium with that of the previous year, it is evident that considerable progress has been made in tunneling technology in moderately hard ground. Much less progress appears to have been made in tunneling through the alluvium and saturated soils that will usually be encountered in constructing rapid transit systems under cities. There are already research studies aimed at evaluating the use of liquid gases to freeze the ground and provide interim support for the tunnel and for structures near the right-of-way. This appears to be a particularly apt area for application of NASA technology in view of the large amount of NASA experience in the storage of liquid oxygen. A preliminary search of the cost factors developed by NASA in this technology was ordered from Western Research Application Center (WESRAC) for the purpose of following this opportunity.

This problem shares the institutional constraints we find, as expected, in dealing with the public sector in the field of transportation. The detailed technical problems are not to be found in the public agencies. The ultimate user will be a rapid transit district, other regional authority, or the Federal Government, because the ultimate public benefit from the technology application derives from cost or other savings that accrue to the public agency, but the actual applier will be an equipment supplier or a construction contractor, both in the private sector. To reach the problem it is necessary to sell the public sector agency on the benefit that they derive and enter discussions with the supplier or

contractor, in some cases through an architect engineering firm, under the public agency's aegis. For expensive and significant new developments the public agency and the suppliers all look to the U.S. Department of Transportation for support of research and development activities that precede the application of new transit, construction, or tunneling technology. For this reason we believe it most fruitful for the technology application to be put under the aegis of the Department of Transportation.

Follow-Up Contracts in the Field of Transportation by E. C. Wood

A third meeting was held with Operations staff personnel of Southern California Rapid Transit District on December 9. The meeting was primarily oriented toward developing information on problems already identified. One new problem--materials or coatings for interior surfaces of the vehicle to promote release of dust and soil--was identified.

Additional contacts were made with BARTD--following up Problem Statement T-31, Derailment Detector, submitted to them November 18 for comment--and California Division of Highways to obtain additional information and arrange a January 5 appointment in Sacramento to discuss background on several of the 28 problems they have identified.

On November 21, the general problem of tunneling was discussed with Mr. R. J. Proctor of the Los Angeles Department of Water and Power. Two areas merit exploration from his viewpoint--(1) cryogenic freezing to stem water flow and to hold loose, wet formations, and (2) tool wear in hard rock drilling heads. He recommended contractors and tool vendors with whom these problems could be discussed under MWD aegis; initial contacts are scheduled in January.

A letter was sent to Mr. Warren Queenstadt, Washington Metropolitan Transit District, to prepare the way for a visit to introduce the TAT program during an early visit in Washington.

William C. Thuman

William C. Thuman, Director
Technology Applications Team

Approved:

C J Cook by mcl

C. J. Cook, Executive Director
Physical Sciences Division

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